Space Technology Research Grants

Adaptive FSI of flexible parachutes under strong dynamic loading using strongly coupled shell mechanics and large-eddy simulation with analytical curvilinear hybrid meshing

Completed Technology Project (2017 - 2020)

Project Introduction

Future robotic and human space missions to planets and moons in the solar system will involve entry vehicles with higher masses than that of any currently available vehicle. Slowing down these vehicles during entry, descent, and landing (EDL) into the atmosphere is in part accomplished by using deployable light-weight parachutes, although they have limited robustness. This proposal concentrates on the development of high-fidelity physically-based computational models of flexible parachutes. Their dynamics must be accurately predicted by the computational model, specially during the challenging phase of deployment and inflation. Unsteady forcing of the parachute by the afterbody flow must be predicted accurately to evaluate the stability and integrity of the structure for a wide range of conditions in a cost-effective manner. The flexible structure of the parachutes is made of composite woven fabrics of strong fibers impregnated in a polymer matrix and exhibit anisotropic nonlinear constitutive behavior. We proposed the development of a novel high-fidelity fluid-structure interaction (FSI) computational tool that can be applied to the analysis of subsonic and supersonic parachutes under the strong dynamic loading conditions encountered during deployment (where failure modes seem to concentrate). The physical elements implemented in the tool include turbulence modeling by large-eddy simulation, nonlinear structural shell mechanics, and robust contact treatment. Furthermore, a novel hybrid gridding idea will be demonstrated to dramatically reduce current FSI time-to-solution costs. This research will help NASA by providing with a unique tool to help in the design of parachutes at a reduced cost and effort

Anticipated Benefits

This research will help NASA by providing with a unique tool to help in the design of parachutes at a reduced cost and effort. The resulting framework will be sufficiently accurate to reproduce most failure modes. Large saving by reducing full scale testing to very refined designs.

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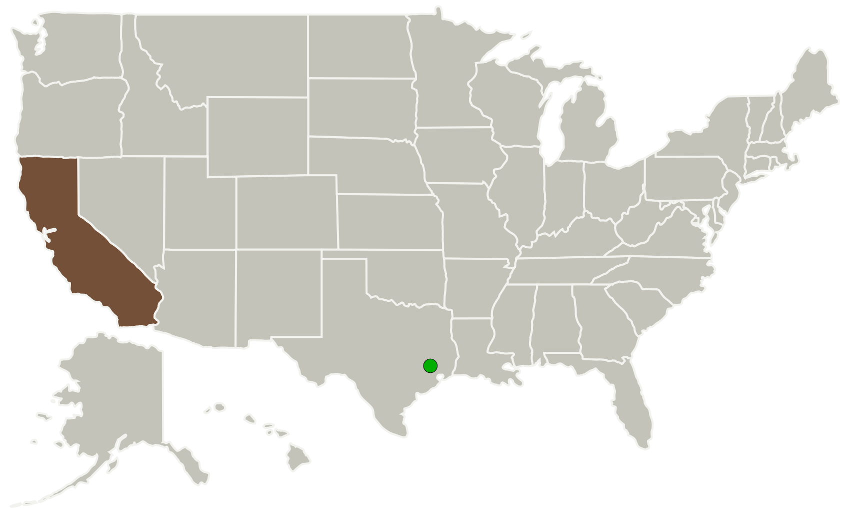
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Southern California(USC)	Lead Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Los Angeles, California
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
University of Cambridge	Supporting Organization	Academia	Cambridge, Outside the United States, United Kingdom

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Southern California (USC)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

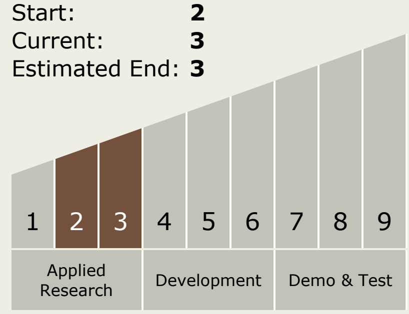
Hung D Nguyen

Principal Investigator:

Carlos A Pantano Rubino

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └ TX09.4 Vehicle Systems
    └ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

Earth, Mars, Others Inside the Solar System